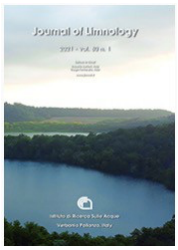

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Fly fishing no-kill zones: a possible way to conjugate conservation issues, sustainable sport enhancement and local development in Alpine areas?

Stefano Fenoglio,[1,2,3*] Marco Baltieri,[4] Paolo Lo Conte,[5] Francesca Marucco,[1,3] Carlo Ruffino,[4] Alberto Doretto[2,6]

[1]Department of Life Sciences and Systems Biology, University of Turin, Via Accademia Albertina 13, I- 10123 Turin

[2]ALPSTREAM – Alpine Stream Research Center, I-12030 Ostana

[3]SUISM - Struttura Universitaria di Igiene e Scienze Motorie, Via A. Ferraris di Celle 2, Cuneo

[4]ATAAI-Associazione Tutela Ambienti Acquatici e Ittiofauna, Via Airali 54, I-10062 Luserna San Giovanni

[5]Funzione Specializzata Tutela Fauna e Flora, Città Metropolitana di Torino, C. so Inghilterra 7, I-10138 Turin

[6]Department of Environmental and Life Sciences, University of Piemonte Orientale "Amedeo Avogadro", Viale T. Michel 11, I-15121 Alessandria, Italy

***Corresponding author**: stefano.fenoglio@unito.it

Running head: Catch and release and trout population dynamic in the Alps

Key words: catch and release; *Salmo trutta*; *Salmo marmoratus*; outdoor sport; fishing management

ABSTRACT

The promotion of sustainable tourism and outdoor sports can represent an important way to couple environmental conservation strategies and economic enhancement in marginal and Alpine areas. In this context catch and release fly fishing zones can represent an interesting tool, although no data is available on the effectiveness of these practices on Alpine salmonid population dynamics. Salmonids are the main group of fish in alpine rivers and they are the only actively targeted by anglers. Aim of this work is filling this gap, with a pilot study on two no-kill zones (Po and Pellice rivers, NW Italy). We conducted a temporal and spatial comparison between free-fishing and catch and release management river sections, with a detailed analysis on the Po River site. Our results support the hypothesis that catch and release management allows a numerical increase in wild trout populations. In particular, we detected a massive and rapid increase in younger individuals, possibly linked to a stop on the removal of large-sized reproducers. Protecting trout by the implementation of this practice can at the same time allow the increase of sustainable economic development and sport in marginal areas.

INTRODUCTION

Conservation is a state of harmony between men and land, wrote Aldo Leopold, the man who changed the history of modern environmentalism developing the concepts of 'land ethic' and 'worldview remediation': he was a prolific writer, an ecologist, a forester, a scientist, a professor and, of course, a fly fisherman. The diffusion of some practices related to fly fishing can be an important strategy to combine environmental protection, biodiversity conservation, sporting activity and sustainable tourism (Arlinghaus *et al*., 2007). At present, rivers are among the most threatened environments in the world (Albert *et al*., 2020), due to pressures acting both at global (e.g.: climate change, Jeppesen *et al*., 2014; Piano *et al*., 2019) and local (e.g.: increased exploitation of water resources, Bruno *et al*., 2016; Tonkin *et al*., 2019) scales. Alpine rivers are particularly important and vulnerable, as on the one hand they still host rich and biodiversified communities and on the other hand they flow in territorial contexts that are often disadvantaged from an economic point of view (Fenoglio *et al*., 2015; Carrer *et al*., 2020; Falasco *et al*., 2020). Alpine rivers, due to the quantity and quality of their waters, are diffusely perceived as one of the most important economic

resources in mountain contexts, where they attract interests for their direct and often not sustainable exploitation. In this context, it is interesting to search for tools consenting to couple conservation needs with an economic return for local human communities. Protecting a river means not only safeguarding its biotic communities and ecological functionality, but also preserving the touristic appeal of the entire area. Outdoor sports are widely recognized as a successful tool to promote sustainable tourism, with important economic and environmental outcomes. Outdoor sport practices are undergoing unprecedent popularity (Brocherie *et al.*, 2015), and they can represent an important way to revitalize local communities in rural and mountain areas, avoiding threats and costs of elevate concentration of tourists and impacting urbanization (Uesugi and Kudo, 2020), but they can also play a crucial role by promoting environmental awareness and then biodiversity conservation. Among outdoor sports, fly fishing can represent a leading example, especially if combined with catch and release practices. Catch and release, also called no-kill regulations, are becoming a diffuse conservation practice in recreational angling, especially when focused on some threatened or charismatic freshwater fish species. This angling approach was born in the 60's of the past century, when numerous United States National Parks adopted a management that prevented from retaining the fish caught in their rivers (Lennon and Parker, 1960). This approach is based on the premise that such fishing is indeed highly sustainable, with a minimal impact on fish populations: numerous studies confirm that the fish caught usually does not suffer irreversible damage and even the same fish can be recaptured several times (Bartholomew and Bohnsack, 2005). There are clear evidences that generally post-release mortality of salmonids caught on flies (i.e., with fly fishing techniques) is lower than those caught with other techniques (Risley and Zydlewski, 2010).

Unfortunately, although catch and release practices are increasingly adopted in the Alpine area, almost no data are available at present to support the real effectiveness of this approach in this region, i.e., practically no studies measured their effects on fish populations. How important is the introduction of a no-kill management for the protection of the fish population of a certain Alpine river stretch? Is no-kill practice a panacea, a good solution, a snobbish ephemeral mode or an economic business with no practical effects on conservation? The aim of this pilot study is to evaluate the impact of no-kill management on some population parameters of Alpine salmonids while the economic repercussions, the

sporting appeal and the tourist influx of fly fishing angling will be discussed elsewhere. In particular, we wondered if the establishment of a regulated no-kill fly fishing zone had any effect on the evolutionary dynamics of the trout populations concerned. Obviously, we considered areas in which not only no fish removal is practiced but also no fish stocking are made.

METHODS

Study area

The present study was carried out in two no-kill fly fishing zones in the Monviso area (Cottian Alps, NW Italy; Fig. 1). The climate is temperate-alpine, with springtime high discharge caused by snowmelt. A first case study concerns the Alpine section of the Po River, near Ostana (CN). Here, a no-kill fly fishing zone was established in 2019 with the authorization of the Province of Cuneo: the zone is 3.25 km long, between the Oncino bridge (913 m asl) and the wooden bridge that crosses the Po River near Ostana (located at 1129 m asl). In the study site, the Po is a typical small order, high gradient mountain stream, with boulders and coarse substrate, small (4–6 m) channel width and a mean depth of 40–60 cm. This stream reach is populated by Brown trout (*Salmo trutta* complex) and European Bullhead (*Cottus gobio* Linnaeus, 1758). The second case study regards the Pellice river, near Luserna (TO). Here, a no-kill fly fishing zone was established in 2018 by the Metropolitan City of Turin, especially in order to offer protection to the native and endangered Marble trout (*Salmo marmoratus* (Cuvier, 1829)). This no-kill zone has a development of 1.85 km, between the Luserna and the Blancio bridges. In this area the Pellice is a typical lower valley environment, with wide channel (12-16 m), mean depth of 60-80 cm, numerous riparian refuges, masses, pebbles and gravel as main substrate components, modest slope and an average elevation of 500 m asl. In addition to the Marble trout, the European bullhead (*Cottus gobio*), the Southern Barbel (*Barbus meridionalis* Risso, 1827), the Italian Barbel (*Barbus plebejus* Bonaparte, 1839), the Vairone (*Telestes muticellus* (Bonaparte, 1837)), the Eurasian minnow (*Phoxinus phoxinus* Linnaeus, 1758) are present in this reach.

Fish samplings

To evaluate the effect of no-kill management on the dynamic of trout populations, two different approaches were used in the Po and Pellice rivers. In the first case we used a

temporal approach by carring out an ex-ante and ex-post evaluation, comparing the population structure before and after the start of the no-kill management. We carried out a first trout sampling on the 22nd of August 2018, before the establishment of the no-kill. We identified and delimited a river section 100 m long, corresponding to a riverbed surface of 552 m^2. Here, we quantitatively sampled using electrofishing, the most common and suitable technique in this type of studies (Penczak and Głowacki, 2008). Each trout was anesthetized, measured and weighed. The total number of individuals (N) was determined by two sequentially samplings in the same stretch and applying the Maximum Likelihood (ML) removal method (Zippin, 1958), for which $N = C_1 * C_2 / C_1\text{-}C_2$. In this method, C_1 indicates the number of catches on the first sampling while C_2 represents the number of catches on the second sampling. This formula provides a reliable estimate of the fish population in the section, which is essential for calculating the population density (individuals per m^2). After 2 years, on the 4th of August 2020, in the same stretch, with the same working team and with the same, identical methods, we carried out a second campaign. Approximate age/length relationship was estimate by analyzing scales of 35 individuals, according to Jonsson and Jonsson (2011).

In the Pellice river, the morpho-hydrological and historic conditions prevented the use of the same approach: size and flow actually prevented an effective quantitative sampling and furthermore the no-kill management was prior to the time of our study, so it was impossible to have previous data. Due to these reasons in this second study area we adopted a spatial approach: to investigate if the establishment of a no-kill regulation had any effect on the trout population we decided to compare fish population characteristics evaluated in no-kill zone with those of a similar adjacent free fishing section. We controlled for morphological, hydrological and environmental river characteristics by choosing two absolutely similar sampling areas and, to avoid contamination due to fish movements, we have left an unsampled section of 300 m between the two areas. On the 26th of August 2020, we simultaneously carried out an electrofishing sampling in the two zones, collecting and measuring in each one the first 200 specimens.

RESULTS

Regarding the Po River temporal comparison study, we collected a total amount of 348 Brown trout during the ex-ante sampling campaign in 2018, and the total number of

individuals estimated by means of the Maximum Likelihood (ML) removal method is 373 individuals. Mean length was 14.8 cm ± 0.27 SE, with a minimum of 4.5 cm and a maximum of 38 cm. Mean weight was 52.2 g ± 3.23 SE, with a minimum of 1 g and a maximum of 526 g. Trout density was 0.63 ind./m^2 with a biomass corresponding to 32.9 g/m^2. After two years, during the ex-post sampling evaluation in 2020, the same reach housed 441 trout, corresponding to a ML estimated total of 507. Mean length was 13.2 cm ± 0.35 SE, with a minimum of 5.0 cm and a maximum of 33 cm. Mean weight was 45.6 g ± 3.02 SE, with a minimum of 2 g and a maximum of 433 g. Trout density was 0.91 ind./m^2 with a biomass corresponding to 36.4 g/ m^2. In addition to the numerical increase, after two years we detected a clear change in the distribution in length (Fig. 2a) and age (Fig. 2b) classes, and a significant difference in the mean length (Fig. 2c). Comparing abundance of the different age classes, significant differences were detected for the 0+ class (χ^2: 77.137; $p<0.001$).
Regarding the Pellice river spatial comparison study, we detected that mean trout length was 16.8 cm ± 0.60 SE with a minimum of 7.0 cm and a maximum of 55.0 cm inside the no-kill, while in the free fishing zone values were 18.4 cm ± 0.41 SE with a minimum of 7.0 cm and a maximum of 39.0 cm. We detected a significative difference in mean length between the two sampled areas (Fig. 2e). Figure 2d shows that, when comparing 200 trout randomly caught outside and inside the no-kill zone, the distribution in size classes is clearly different, with a greater number of small individuals and at the same time with the presence of few large specimens in the no-kill.

DISCUSSION

Fly fishing is not the only technique that can be used in catch and release stream reaches, but it holds high regard due to its touristic and economic interest for recreational fishing (Wheeller *et al.*, 2021). Moreover, there is clear evidence that, considering the lower impact of using flies versus lures and bait, fly fishing tends to be less injurious, with a lower chance of causing post-release mortality in fish (Schisler and Bergersen, 1996; Arlinghaus *et al.*, 2007). Moreover, local laws require fly fishing to be the only practicable technique in the stream reaches with no-kill and no stocking management.

Catch and release practice is attracting growing interest, but according to Cooke and Schramm (2007) a real and effective evaluation of its benefits strictly depends on possible fish population changes. Considering the Po river, we detected an evident (+26%) increase

of individuals that it is likely attributable to the change of fishing management. No other environmental conditions have apparently changed. Our research group has been performing numerous research studies in these two areas for years and we did not detect any significant environmental variation, considering both hydro-morphological and water chemical characteristics (see more details in Falasco *et al*., 2018, 2020; Doretto *et al*., 2020; Gruppuso *et al*., 2021). Moreover, in the two river reaches fish stocking has been forbidden for many years (the Po River is protected within a Natural Park with strict regulations). At first sight, the smaller body size (both in terms of weight and length) found after two years of fish removal prohibition might be confounding, but by a global analysis an interesting picture emerges. The numerical trout increase is essentially linked to a clear growth of young individual number (total length < 15 cm), which represented 50.9 % of the population in 2018 and became 61.5% two years later. This is likely due to the fact that we left in place some large reproducers (which previously could be legally taken away), that were able to reproduce and fill the population of young individuals. We supposed that almost 30/40 fish reached the sexual maturity after change in fishing management in Ostana, considering the growth of the number of specimens with a length >22 cm, by comparing the two sampling years. A similar situation occurred in the Pellice, where out of 200 individuals collected and measured randomly, Marble trout juveniles (total length <18 cm) constituted the 56.5 % inside the no-kill and 47.0 % outside.

CONCLUSIONS

The diffusion of no-kill practices is at an initial phase in the Italian Alps and we believe that these data, although preliminary and concerning only two experiences, can be of interest stimulating attention towards these management practices. At present, the information available regarding the touristic and economic importance of the no-kill is still scarce. Considering that fishermen do not have to pay a daily permit but a regional fishing license to access the zone, it is difficult to quantify the number of fishermen who have visited this area since its establishment. However, at least three factors demonstrate the promising touristic interest of the initiative: i) Mountain Union of Monviso Municipalities has prepared a new illustrative brochure with the list of hotels that practice discounts to no-kill fishermen; ii) fishermen's frequentation of the reaches has increased since the no-kill enactment

(Carabinieri – Forest Police); iii) last summer, local hoteliers have received for the first time some fishermen from Lombardia and Liguria, not only from Piemonte. In addition to these considerations, which will be further quantified with more data available, the manuscript focused on the implications of this new management practice on the restructuring of trout populations. As far as we know, at present these are the first scientific data that support the conservative effectiveness of catch and release practices in Italy, which demonstrates the interesting effect of no-kill practices: not only the no-kill management protected the larger adult organisms, but essentially promoted the positive development of the population dynamic through the recruitment of young individuals. Trout are iconic, but increasingly threatened freshwater fish (Lorenzoni *et al.*, 2019). Numerous researchers underline how the release of trout reared in hatcheries often does not ensure correct continuity for wild populations (Lobón-Cerviá and Sanz, 2018), while reproduction in a natural environment certainly has a more positive impact. Our results seem to support the idea that the diffusion of fly fishing no-kill zones represents an excellent opportunity to promote trout and environmental conservation without necessarily limiting angling opportunities, but on the contrary enhancing sustainable tourism and outdoor sports in many Alpine valleys.

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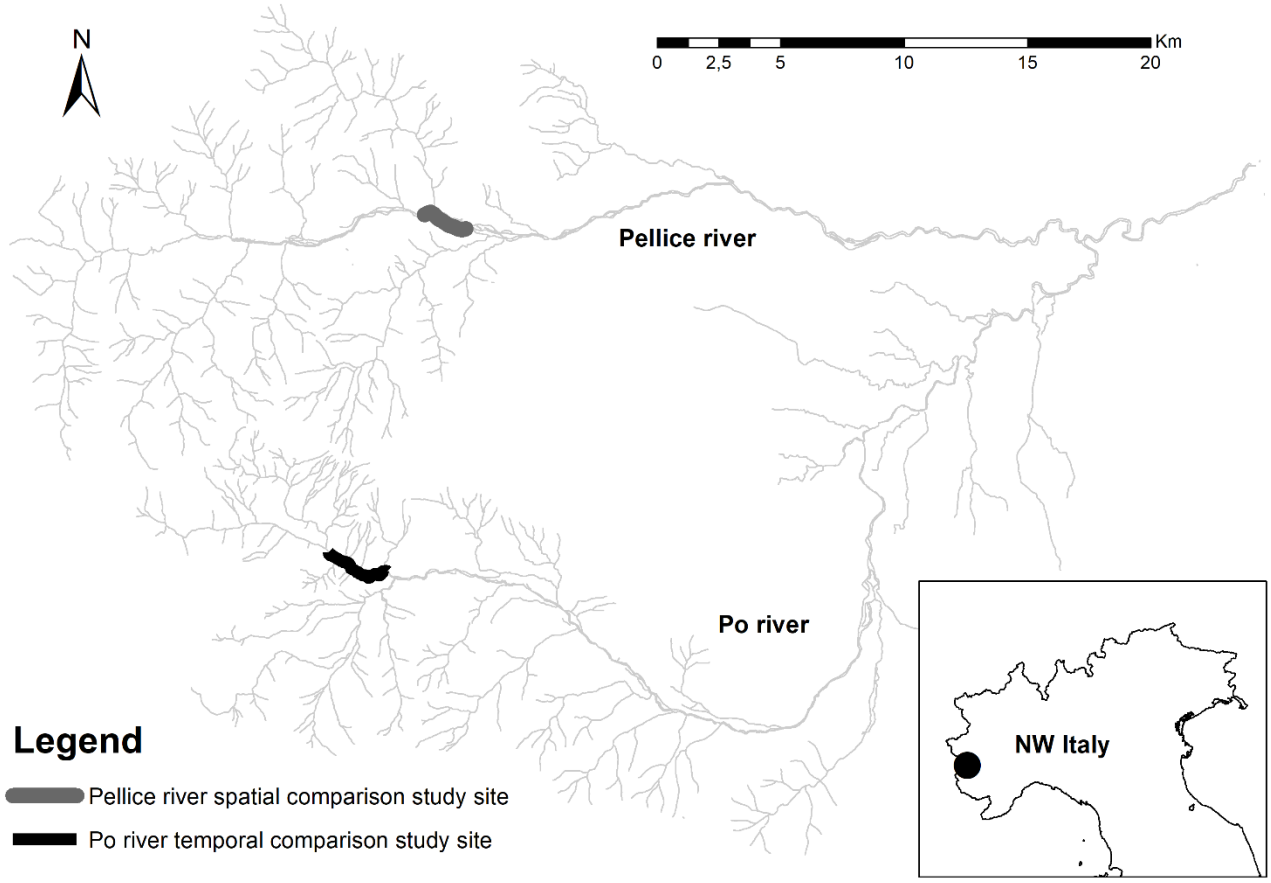

Fig. 1. Overall study area in the Italian Alps, with indications of the two Po and Pellice catch and release study sites.

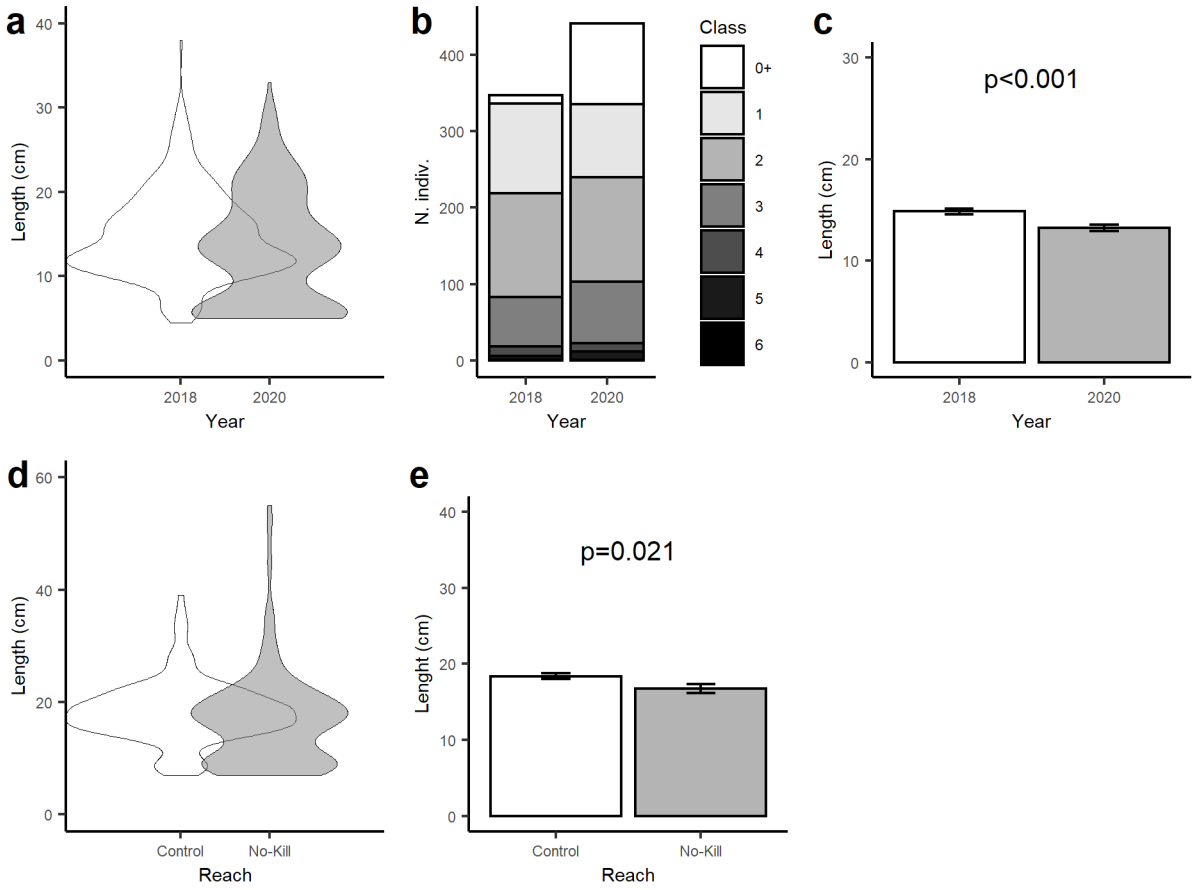

Fig. 2. Comparison between no-kill and free-fishing zones. a) Violin charts show the distribution of the trout's length in the Po River site before and after catch and release regulation. b) Stacked bars indicate the number of trout specimens belonging to each age class. c) Bars indicate the mean body length, while the error bars indicate ±SE. d) Violin charts show the distribution of the trout's length in the Pellice river site by comparing the no-kill section and outside free-fishing (i.e., control) section. e) Bars indicate the mean body length, while the error bars indicate ±SE.